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(54) INTEGRATION SENSOR ELEMENT AND MEASUREMENT SYSTEM USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an integrated sensor element that is even though short in life time but has a structure suited for mass production and can be exchanged automatically, and a measurement system for achieving continuous monitoring at a low cost by the integrated sensor element.

SOLUTION: In this integrated sensor element, a sensor part 6 for detecting the quantitative changes or concentration changes of a substance, a control part 7 for processing a signal for indicating the detection result, and an antenna part 10 for transmitting a processed signal to the outside and at the same time, receiving energy required for the transmission operation and the operation of the sensor part 6 and the control part 7 from the outside are formed as a single integrated circuit element.

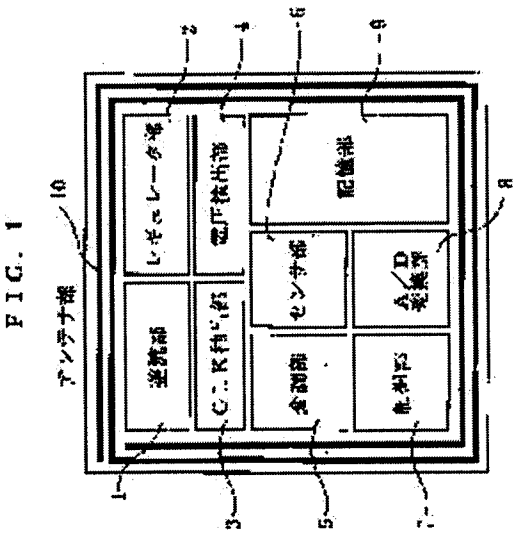


FIG. 1

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the integration sensor element which detects the quantitative alteration of the substance for measurement, and the instrumentation system which uses this.

[0002]

[Description of the Prior Art]The sensor used for detection (or measurement) of the quantity (concentration is included) of a substance is provided with various things. For example, the integration ion sensor with which the ion sensing membrane, the digital disposal circuit, and the reference electrode were collected by the one chip is indicated by JP,4-363651,A. Two or more contact buttons are provided in this integration ion sensor, and supply of electric power and collection of a detection result are performed via the line linked to that terminal.

[0003]The sensor currently indicated by JP,6-42983,A and JP,11-311615,A has the composition which sends and receives the energy for operating a detection result and its sensor by wireless between external devices.

[0004]Generally the life of these sensors is limited. That is, measurement performance deteriorates temporally by exposing a sensor to an operating environment etc. Generally especially the chemical sensor and biosensor that perform not measurement of temperature, a pressure, etc. but detection of a substance, etc. are lacking in prolonged stability. So, it is required to replace the sensor which deteriorated with a new thing, and the work is done so frequently that the life of a sensor is short. Since it is complicated that a worker judges degradation of a sensor, the measuring instrument which judges life arrival of a sensor automatically and reports the necessity for exchange to a worker is indicated by JP,9-297832,A.

[0005]

[Problem(s) to be Solved by the Invention]However, there were the following problems in the conventional sensor.

[0006]The sensor which assembled two or more substrates which have arranged the electric circuit for measurement signal processing like JP,6-42983,A has complicated wiring structure, and it is large-sized. Generally as for such a sensor, a manufacturing cost becomes high.

[0007]Since the connection between this and an external device is a cable even if it forms a sensor by a one chip like JP,4-363651,A, there is a problem of costs and reliability, such as complicatedness of sensor exchange, a help's intervention, a high cost of replacement parts, and the reliability of connection of a connector.

[0008]When reporting the necessity for sensor exchange to a worker, like JP,9-297832,A a measuring instrument, If it is used only when there is a worker, it will be satisfactory, but when a worker is not in the neighborhood and it measures, a worker cannot be told only by

displaying the necessity for sensor exchange. Since it must come and exchange till the place whose worker is a measuring instrument and a help intervenes, even if it is able to tell about by other methods, while there is a problem of cost, there is a problem of the reliability of connection of a connector. For example, when a measuring object is a dangerous medicine, sensor exchange becomes still more complicated and becomes a high cost.

[0009]Although it is common in any case, When installed in the place where it is very difficult for a measuring instrument to exchange by the place or help whom a help does not reach, When used at the deep place underground and in the sea, the inside of a pipe, or a place like space, it will become impossible for example, to use the measuring instrument in the above methods in the stage at which the life of the sensor arrived. This is fatal to detection or measurement.

[0010]On the other hand, since many investment, a long development cycle, and a great risk are followed on development of the sensor element which it is long-life and does not need clearing work for a long period of time, especially responsive membranes, although it is short-life, the actual condition is using the cheap sensor producible with the present art.

[0011]The first purpose of this invention is to provide the integration sensor element which secured economical efficiency by considering it as the integration structure of a one chip suitable for mass production, although the life of each sensor element is not long. The second purpose is to provide the instrumentation system which enables continuous prolonged measurement without through a help by enabling it to do automatically the work which exchanges for a new sensor element the sensor element which faced and deteriorated for measuring using such an integration sensor element.

[0012]

[Means for Solving the Problem]A primary detecting element having a converter which changes into an electrical signal an organic layer which produces a characteristic change when an integration sensor element of this invention touches a gas or a fluid containing a substance, and its characteristic change, A control section which processes a signal which shows the detection result, and an antenna section which receives energy required for operation of the send action and primary detecting element, and a control section from the exterior while transmitting a processed signal to the exterior were formed as a single integrated circuit device.

[0013]A primary detecting element constituted with an ion sensitivity FET element of this invention from which an integration sensor element [like] detects pH concentration in solution 1 operative condition, and a reference electrode, A temperature sensor for amending the detection result, and a control section which processes a signal which shows a detection result from said primary detecting element, While transmitting a signal processed by said control section to the exterior, an antenna section which receives energy required for operation of the

send action and said primary detecting element, and said control section from the exterior was formed as a single integrated circuit device.

[0014]According to the desirable embodiment of this invention, a control section is constituted so that it may have a memory which memorizes beforehand correction information for amending a detection result in a primary detecting element and an amended detection result may be transmitted.

[0015]An antenna section which sends energy supplied to an integration sensor element while receiving a detection result (or amended detection result) transmitted from an integration sensor element of this invention, A reader provided with an indicator which displays information about a detection result received from an integration sensor element via this antenna section is provided.

[0016]This invention is characterized by an instrumentation system comprising the following.

A container which stores two or more above-mentioned integration sensor elements.

An actuator which eliminates a sensor which only predetermined quantity changed into an usable state an integration sensor element stored by this container, and deteriorated.

A controller which judges whether a hour of use which judged performance degradation of an integration sensor element, or was decided beforehand passed, and controls operation of an actuator.

An antenna section which sends energy supplied to the sensor element concerned while receiving a detection result transmitted from an integration sensor element in use.

[0017]In an instrumentation system of this invention, two or more containers which store every one above-mentioned integration sensor element may be used. As for those containers, it is preferred to have adsorbent which adsorbs a substance which has the airtightness which prevents invasion of a gas from the outside or a fluid, or degrades an integration sensor element inside.

[0018]As such a container, it has the lid formed by a part or film with thin all, and a container which encloses one integration sensor element at a time with a gas or a fluid which holds an integration sensor element stably is used suitably, for example.

[0019]According to this invention, a storage device provided with two or more stowage containers which store two or more above integration sensor elements by a sealed state, or containers which stored one integration sensor element at a time by a sealed state is also provided.

[0020]

[Function and Effect]According to the integration sensor element of this invention, the detection result in a primary detecting element is processed by a control section, and it is transmitted to the exterior via an antenna section, but energy required for the operation in the transmission

and primary detecting element, and control section is also supplied via the antenna section concerned. That is, transmission and energy supply of a detection result are performed by wireless. Therefore, even if a measuring point is changed, it can respond flexibly. Since an integration sensor element forms in a one chip the primary detecting element, control section, and antenna section which are the component as a single integration element, it is small and it is the structure to which the wiring etc. to which each part is connected were formed in one, and fitted mass production.

[0021]Since the integration sensor element of this invention performs transmission and an energy supply by wireless in addition to planning cost reduction by having been integrated to the one chip as mentioned above, there is no problem in the reliability of connection and exchange of a sensor element is also easy for it.

[0022]In the instrumentation system of this invention, predetermined quantity is changed into an usable state among two or more integration sensor elements stored by the container with the actuator. And while a transmission and reception section receives the detection result transmitted from the integration sensor element in use, the energy supplied to the sensor element concerned is sent. When the performance of an integration sensor element in use deteriorates, and a controller judges performance degradation and controls operation of an actuator, the integration sensor element concerned is eliminated and an intact integration sensor element is changed into an usable state. That is, the integration sensor element which deteriorated is automatically exchanged for a new integration sensor element. Therefore, since a help does not start exchange of a sensor element but it can exchange promptly also by a short-life sensor element, continuous measurement of the long period of time for not using a long-life sensor element is possible.

[0023]Exchange by a help can apply the instrumentation system of this invention also at a difficult or impossible place.

[0024]Since the integration sensor element is stored in the container, the kind and range of an usable sensor element are wide, and the high instrumentation system of flexibility is provided.

[0025]

[Embodiment of the Invention]Drawing 1 is an enlarged drawing showing typically the composition of the integration sensor element by this invention. The integration sensor element is formed in the one chip. The internal configuration of the chip is classified into the rectification part 1, the regulator part 2, the CLK (clock) extraction part 3, the voltage detector 4, the modulation part 5, the primary detecting element (sensor part) 6, the control section 7, the A/D (analog/digital) converter 8, the storage parts store 9, and the antenna section 10 for every functional block.

[0026]The primary detecting elements 6 are various things, and can constitute. For example, when the amounts of substance for measurement are a hydrogen ion and a hydrogen ion

exponent (pH), a publicly known ion sensitivity electric field effect type transistor (ISFET) can be used as a primary detecting element. This constitutes the gate from films, such as an oxide from which surface potential changes with the concentration changes of a measurement target substance. In this case, the primary detecting element 6 has ISFET and a reference electrode, and outputs the signal which changed the surface potential of the gate oxide of ISFET by FET as a detection result of pH.

[0027]The organic layer from which the primary detecting element 6 otherwise produces a characteristic change by the concentration change of a measurement target substance, etc., The thing provided with the converter which changes the characteristic change into an electrical signal may be used, Measurement of the resistance by a comb shaped electrode, or capacity value, the capacity measurement by a parallel plate electrode, It can use for detection of the weight change by QCM (Quartz Crystal Microbalances), the weight change by a SAW (Surface Acoustic Wave) element, or the weight change by a cantilever (cantilever). In this case, as a detection result, the primary detecting element 6 changes physical quantity, such as gas concentration, stress, and an elastic coefficient, into an electrical signal, and outputs it.

[0028]the control section 7 shows a detection result -- signal processing is carried out and amendment (for example, amendment for a calibration) of a detection result is also performed. Required information (henceforth correction information) is stored in the storage parts store 9 when amending. For example, the zero point information on each sensor element, measuring range (Sepang) information, temperature-characteristics information, etc. are memorized. These zero point information, the Sepang information, etc. can perform data conversion which set measurement data by the characteristic of each sensor. When a temperature sensor is also formed by integration or external, it becomes possible to apply amendment to temperature information by the temperature characteristics of each sensor. The program for signal processing besides the information on Sepang etc. is also included in correction information. The control section 7 amends a detection result according to the program.

[0029]When using two or more integration sensor elements simultaneously, the primary detecting element of each element may form for a different raw material. In that case, ID (Identification) information for identifying an integration sensor element is stored in the storage parts store 9. ID information is transmitted to an external device (for example, the below-mentioned reader) with a detection result. The external device can identify the detection result transmitted from integration sensor element itself or the sensor element concerned by reading this ID information. An external device is prevented from reading the data which made the mistake in being unrelated to a detection result, and information. Thus, the reliability of detection can be improved by using ID information.

[0030]The antenna section 10 transmits a detection result to an external device.
On the other hand, the energy supplied with microwave etc. is received from an external

device.
The energies supplied via the antenna section 10 are the rectification part 1, the regulator part 2, the CLK extraction part 3, and the voltage detector 4, and are changed into current required to operate each part of the integration sensor element concerned, voltage, or a clock signal.
[0031]Drawing 2 is a block diagram showing the integration sensor element of drawing 1, and the composition of a reader. Integration sensor element A and reader B send and receive a detection result or energy mutually.
[0032]First, the function of integration sensor element A is explained.
[0033]The primary detecting element 6 outputs the detection result as an electrical signal (analog signal) which changes continuously. The detecting signal is changed into a digital signal by the A/D conversion part 8.
[0034]The control section 7 performs processing required about the signal (detecting signal) which shows a detection result. On the occasion of the processing, when amendment is required, the control section 7 processes amendment etc. with reference to the correction information stored in the storage parts store 9. Here, not only linearity but the correlation processing before and after processing, i.e., the relation of the input and output in the control section 7, may be nonlinear about a detecting signal. Amendment of a detection result is performed by an integration sensor element, and also it may carry out by the external device which receives a detecting signal.
[0035]The modulation part 5 modulates the subcarrier of the signal processed by the control section 7. It is transmitted from the antenna section 10 and the modulated subcarrier is received by the antenna section 16 of reader B.
[0036]Energy is supplied to this integration sensor element A from an external device (in the case of the example of a graphic display reader B). Electromagnetic waves are used for transmission and reception of the detection result between the antenna section 10 of integration sensor element A, and the antenna section 16 of reader B, and energy. The CLK extraction part 3 extracts a clock signal from the received electromagnetic waves. The control section 7 operates based on this clock signal.
[0037]The energy supplied via the antenna section 10 is rectified by the rectification part 1, and voltage is adjusted in the regulator part 2. In this way, the rectified direct current serves as a power supply which operates each part. The voltage detector 4 gives the signal which shows that the predetermined voltage level is reached to the control section 7, and he is trying to operate only in the state where the control section 7 can operate.
[0038]Next, reader B is explained. It is received by the antenna section 16 and the subcarrier transmitted from integration sensor element A is inputted into the BPF (band pass filter) section 13. In the BPF section 13, an excessive ingredient is removed from the frequency component of a subcarrier. That is, only a predetermined frequency component including the

information on the processed detection result is extracted. It is inputted into the demodulation section 14, a detection result is taken out by the frequency oscillation which the oscillator 12 generates here, and the subcarrier from which the excessive frequency component was removed is displayed on the indicator 15. It may be made to display the result of having performed other signal processing further to the detecting signal, in the indicator 15. The signalling frequency from the oscillator 12 is amplified by the power amplification section 11, and is transmitted to integration sensor element A as microwave and other electromagnetic waves from the antenna section 16.

[0039]Drawing 3 shows the example of composition of the instrumentation system by this invention. This instrumentation system comprises the take-up reel 17, the feed reel 18, the actuator 19, the perforation machine 20, the containers 21-25, the membrane seal 27, and the transmission and reception section 26.

[0040]In each container, the integration sensor element (henceforth a "sensor chip") is stored. The sensor chip in a container is isolated with the external world with the membrane (thin film) seal 27 so that it may mention later. When a sensor is used for a membrane seal, it is opened with the perforation machine 20. The transmission and reception section 26 receives the detection result transmitted from the sensor chip (inside of the container 23) in use. On the other hand, the energy supplied to the sensor chip is sent.

[0041]The take-up reel 17 and the feed reel 18 interlock by what put the container in a row to band-like with the membrane seal 27 (henceforth the belt of a container). The belt of the unopened container is wound around the feed reel 18. On the other hand, the belt of the container after use is rolled round by the take-up reel 17. These rotate by driving sources, such as a motor. At this time, even a container is sent to the feed direction which the belt of a container shows to drawing 3 by an arrow every. Between the take-up reel 17 and the feed reel 18, the perforation machine 20 which moves reciprocately with the actuator 19 is formed. The perforation machine 20 can open many holes in the membrane sticker stuck on the upper surface of the container 23 to be used.

[0042]Drawing 4 is an expansion perspective view of the container in the instrumentation system of drawing 3.

[0043]The container 28 carries out vacuum forming of the crevice to flexible plastics, such as VCM/PVC. The membrane seal 27 comprises thin films (membrane), such as VCM/PVC, is bonded to the upper bed of a container by thermo-compression, and seals the inside of a container. Inside this sealed container, the sensor chip 29 is stored with deoxidization material, a moisture absorption material (not shown), etc.

[0044]Not only VCM/PVC but air, moisture, and gas should not just pass the material of the container 28 and the membrane seal 27. For example, the composite of an aluminum thin film

and polymers material, aluminum foil, etc. may be substituted. What laminated the polymer materials from which the characteristic differs may be used.

[0045]Drawing 5 is a flow chart showing operation of the instrumentation system shown in drawing 3.

[0046]The exchange time of a sensor is judged by a controller (ST1). controllers should be exchanged -- "YES" when it judges -- if it becomes, directions of operation will be given to the motor etc. which drive the take-up reel 17. As for the belt of a container, even a container is sent only a part by this (ST2) and the unopened container 23 is placed just under the perforation machine 20. Next, a controller gives directions of operation to the actuator 19. By this, the perforation machine 20 descends and a hole is opened in the membrane seal 27 of the container 23 (ST3). By this, the open air comes to contact the sensor chip saved in the inside of a container. Namely, a sensor chip will be in an usable state. And the characteristic of the external world is measured by this sensor chip (ST4).

[0047]By the way, the ion sensor using the organic layer of ion sensitivity, Since there is generally a problem that it does not have the characteristic stable at the time of the beginning of using when it is kept in a drying atmosphere, he is trying to make it stabilize by immersing a sensor in a suitable solution overnight etc. when using it (called a "conditioning"). Then, when using such a sensor, it is preferred to fill the solution for conditionings in the sensor chip container of the above-mentioned example, and to keep a sensor chip in it. For example, if it is Na ion sensor, it will be kept in the Nacl solution of 0.1N.

[0048]In this case, it is good to replace with the perforation machine 20 and to form the following means in the system of drawing 3. Namely, as shown in drawing 10, when the whole system is put in a measuring object fluid and the quantity of a substance, etc. are measured, Hold the tube 61 which absorbs the fluid concerned, and the tube 62 to discharge in the perpendicular direction by the suitable attachment component 63, and form the pump 64 in the suction tube 61, and. The suction needle 61n and the discharge needle 62n are attached to the lower end of each tube, respectively, and it is considered as the structure of making the attachment component 63 moving reciprocately with said actuator 19. On the other hand, the inside of the unopened container 24 and 25 by the side of the feed reel 18 is filled with the conditioning solution L, and is keeping the sensor chip in it.

[0049]in the system of drawing 10, sensor chips should be exchanged as mentioned above -- when it judges, the container 23 which drove the take-up reel 17 and stored the intact sensor chip is placed just under the suction needle 61n and the discharge needle 62n. Then, with the actuator 19, the suction needle 61n and the discharge needle 62n are dropped, and a hole is opened in the membrane seal 27 of the container 23. And if a measuring object fluid is absorbed from the suction tube 61 and it goes into the inside of the container 23 via the suction needle 61n by operating the pump 64, The conditioning solution L with which the inside

is filled up is extruded by the discharge tube 62 via the discharge needle 62n, and is discharged from the upper bed. In this way, the inside of the container 23 is filled with a measuring object fluid, and the sensor chip currently kept in it touches a measuring object fluid. Namely, the fluid in a container can be replaced promptly and a sensor chip can be changed into an usable state. The pump 64 may always work or may be intermittently worked only at the time of necessity.

[0050]It is desirable to provide in the position which left the suction opening and the outlet so that the discharged fluid may not be absorbed again.

[0051]Although the above-mentioned instrumentation system is composition which uses only one sensor chip (sensor chip which is stored by the container 23 in the case of drawing 3) for measurement, It may have composition which can perform measurement by two sensors by also making usable sensor chips other than this sensor (for example, inside of the front container 22), namely, forming the transmission and reception section 26 in that sensor chip also below. In this case, when one sensor in use should be exchanged, the reliability of the sensor (measurement data) used till then can be checked by also using another sensor, measuring simultaneously by two sensors, and judging how much differences of each measurement data there are. By the result, measurement by an old sensor can be stopped in the place where a certain fixed time passed, and the sensors can be collected.

[0052]Drawing 6 shows another instrumentation system. This instrumentation system is provided with the shutters 30 and 31, the stoppers 32 and 33, the storage device 34, and the transmission and reception section 35.

[0053]The storage device 34 is formed with a box shaped member in the air or container, and two or more sensor chips 29 are arranged in the single tier by the inside. To the horizon, this container 34 inclines and is installed. The internal surface of the container 34 is made from material with small friction with a sensor chip, and a sensor chip slides down a slant face by gravity. The inside of the container 34 is sealed with the screw cap 37, the seal ring 38, and the shutters 30 and 31.

Secrecy with the external world is fully maintained.

Inside the container 34, degradation of the intact sensor chip 29 is prevented by installing the adsorbent 43 from which oxygen and humidity are removed.

[0054]The shutters 30 and 31 and the stoppers 32 and 33 are usually in the closed position shown in drawing 6, and the intact sensor chip 29 is kept in the container 34 sealed by the second shutter 31. When exchanging sensor chips, the shutters 30 and 31 and the stoppers 32 and 33 slide in the direction shown by an arrow. These sliding is realized by the drive mechanism D like a solenoid, for example. As for the part which the shutters 30 and 31 and the first stopper 32 of container 34 inside drive, secrecy is fully maintained. Therefore, the open air does not invade into the inside of a container from these sliding portions.

[0055]Although the sensor chip 29 is not usually accommodated in the preparation room 39 which is the space sealed with the first shutter 30 and second shutter 31, when exchanging sensor chips, the second shutter 31 goes up like the after-mentioned. On the other hand, since the first shutter 30 has descended, the open air cannot advance inside preserving chambers and the intact sensor chip in preserving chambers can be kept more for a long period of time.
[0056]On the other hand, the sensor chip 36 used outside the container 34 is fixed to a prescribed position by the second stopper 33, and energy is supplied from the transmission and reception section 35. The detection result in the sensor chip 36 is transmitted from the transmission and reception section 35. The used sensor chips 41 are collected by the recovery bag 42.
[0057]Drawing 7 is a flow chart showing the operation procedures of the shutters 30 and 31 in the instrumentation system of drawing 6, and the stoppers 32 and 33.
[0058]First, a controller judges the exchange time of the sensor chip 36 in use (ST5). And when it judges as "YES, i.e., the stage which should be exchanged,", the second stopper 33 is dropped first and the sensor chip 36 is discharged as a used thing (ST6). The discharged sensor chip 41 is slipped down to the recovery bag 42, as shown in drawing 6. Then, the second stopper 33 is raised to the original position (ST7).
[0059]Next, the second shutter 31 is raised and new top sensor chip 29' is made to slip down in the spare room 39 from the inside of the container 34 (ST8). At this time, the sensor chip 29 of the 2nd henceforth is stopped by the first stopper 32 in the preservation container 34. Then, after dropping the second shutter 31 and closing (ST9), the first stopper 32 is raised, the first stopper 32 is dropped in the place where the first sensor chip 29 was stopped with the second shutter 31, and the following sensor chip 29 is stopped (ST10).
[0060]Next, the first shutter 30 is raised and sensor chip 29' in the spare room 39 is moved to a using position (36) (ST11). Then, the first shutter 30 is dropped and the spare room 39 is closed (ST12). It is preferred to remove here the fluid and humidity of the spare room 39 exposed outside.
[0061]The sensor chip in a storage device is taken out by the above outside, when [one / every] it should exchange, and by it, it will be in an usable state.
[0062]Drawing 8 shows another instrumentation system. This instrumentation system is provided with the cartridge C, the substrate 44, and the actuator D.
[0063]The cartridge C consists of the upper case 45 and the lower case 46. The axis 47 of the upper case 45 fits in pivotable with the bearing 48 of the lower case 46, and it engages with the below-mentioned principal axis 49. At the time of use, the upper case 45 and the lower case 46 are put together, and it is united.
[0064]The actuator D is provided with the motor 50, the reduction gear 51, and the principal axis 49, and is constituted. The reduction gear 51 adjusts number of rotations, and transmits

the power of the motor 50 to the principal axis 49. An actuator is installed in the back side of the substrate 44. However, the principal axis 49 penetrates the substrate 44 and engages with the upper case 45 of the cartridge C. The power of the motor 50 is transmitted to the upper case 45 via the principal axis 49.

[0065]The breakthrough 52 is formed in the upper case 45. Two or more dens 53 are established in the lower case 46. The sensor chip 54 is stored by each den 53. It is preferred to put here the adsorbent which adsorbs humidity and oxygen with a sensor chip into each den. In the case of measurement, the upper case 45 and the lower case 46 are put together, and the secrecy of the den 53 is held. The sensor chip 54 located just under the breakthrough 52 is exposed to the open air. The sensor chip exposed to the open air sends and receives a detection result or energy between transmission and reception sections (not shown).

[0066]The upper case 45 engages with the principal axis 49 as mentioned above. On the other hand, the lower case 46 is being fixed to the substrate 44. The lower case 46 and the substrate 44 are removable. as for the upper case 45, a sensor chip is located just under the breakthrough 52 -- as -- every [predetermined under the power of the motor 50 / an angle] -- it rotates. That is, in this example, when the life of a sensor chip is exhausted, it has a mechanism changed to the following new sensor chip by rotating the upper case 45.

[0067]The cartridge C and the substrate 44 are engaged removable. Therefore, the existing cartridge can be replaced with a new cartridge when the life of all the sensors 54 stored to the den 53 is exhausted.

[0068]Drawing 9 is a block diagram showing the electric power supply to the instrumentation system shown in drawing 8.

[0069]The controller 58, the driver 55, and the receiving circuit 57 are driven with the power supply from the power supply 56. The controller 58 judges the life of a sensor chip and gives directions of operation suitably to the driver 55. The driver 55 controls operation of the actuator D of drawing 8. Specifically, the principal axis 49 of drawing 8 controls rotation of the motor 50 so that predetermined rotates an angle every. Feedback control may be carried out using a potentiometer etc. as the method of control, and open control can also be carried out using a pulse motor. The receiving circuit 57 receives the detection result by the sensor chip 54 of drawing 8, and it is a circuit for supplying energy to a sensor chip.

[0070]As mentioned above, although the example of the integration sensor element and the instrumentation system was described, the shape of a sensor chip, the shape of a container, or the drive system of an actuator is not limited to the above-mentioned example.

[0071]For example, in the integration sensor chip of drawing 1, the sensor part 6 may consist of two or more sensors. Those sensors measure each ion of a hydrogen ion exponent (pH) and Na and K, and Ca, for example. In this case, since manufacture can also be managed at once while being able to share the reference electrode integrated by one chip, the temperature

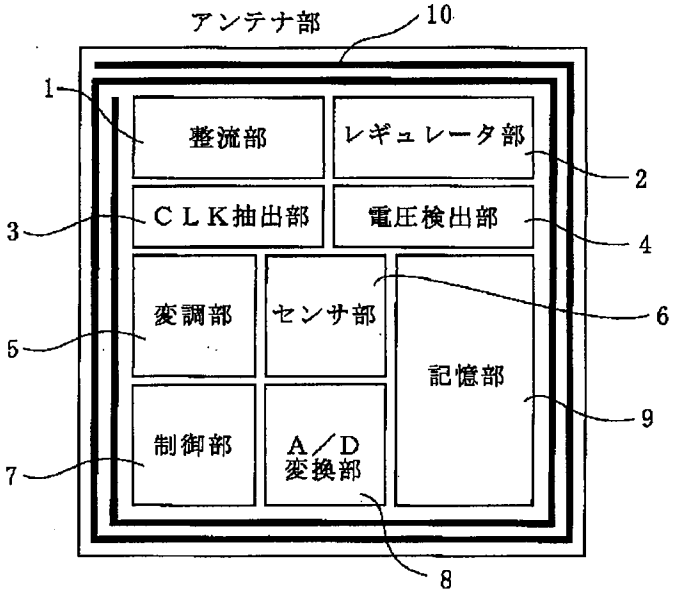
sensor for compensation, etc., it is more advantageous in respect of cost than making two or more integration sensors by which measuring objects differ.

[0072]Although the integration sensor element and instrumentation system by this invention are applicable to various physical quantity measurement, they are suitable for other manure monitor and environmental measurement of hydroponics.

[Translation done.]

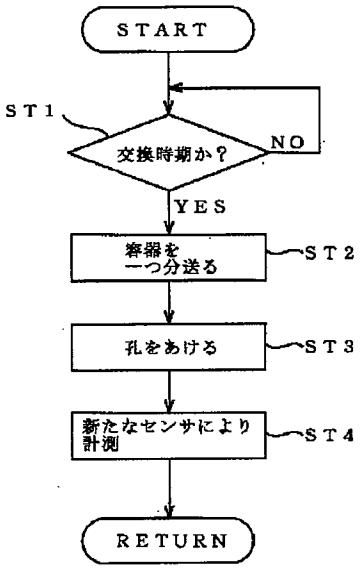
[Drawing 1]

F I G. 1



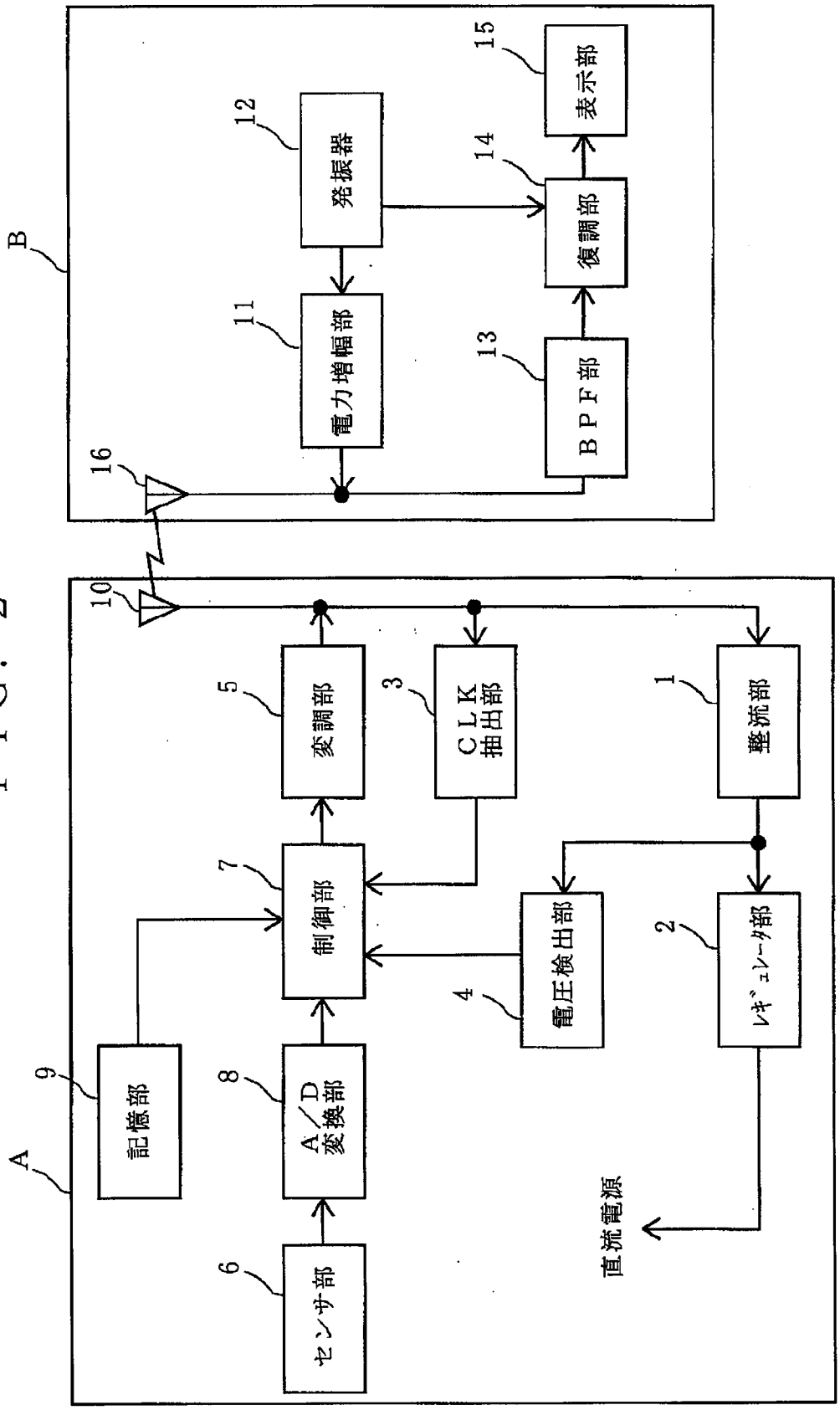
[Drawing 5]

F I G. 5



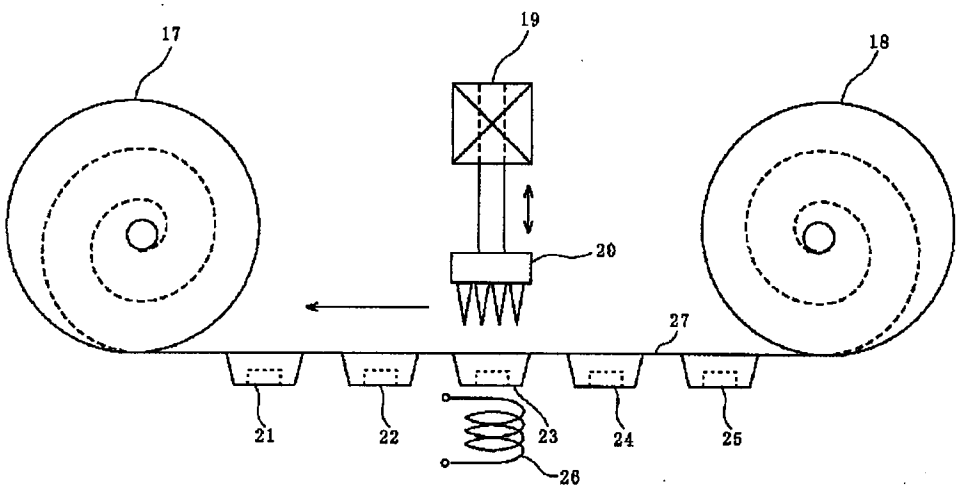
[Drawing 2]

FIG. 2



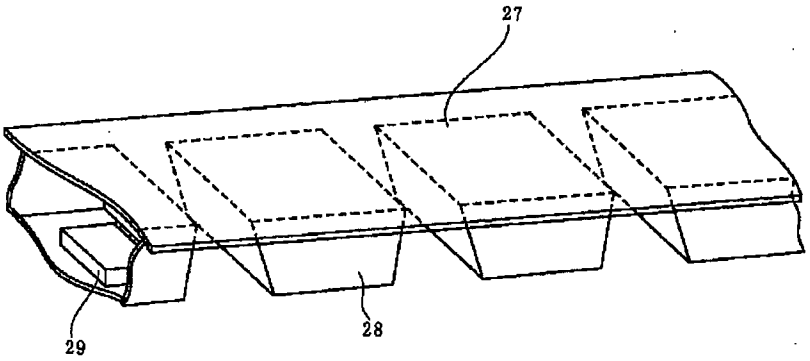
[Drawing 3]

F I G. 3



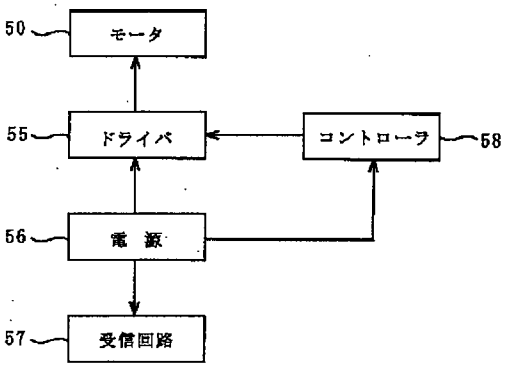
[Drawing 4]

F I G. 4



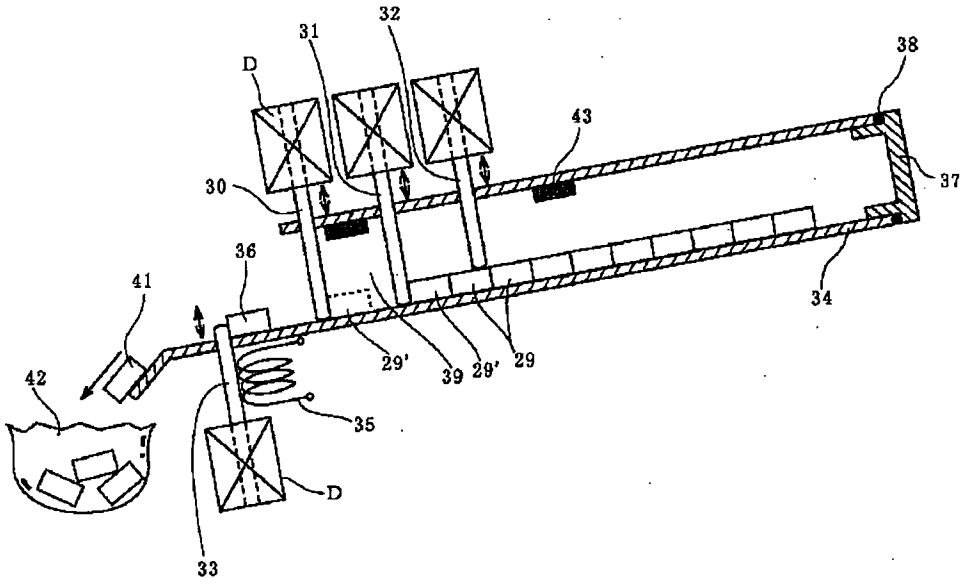
[Drawing 9]

F I G. 9



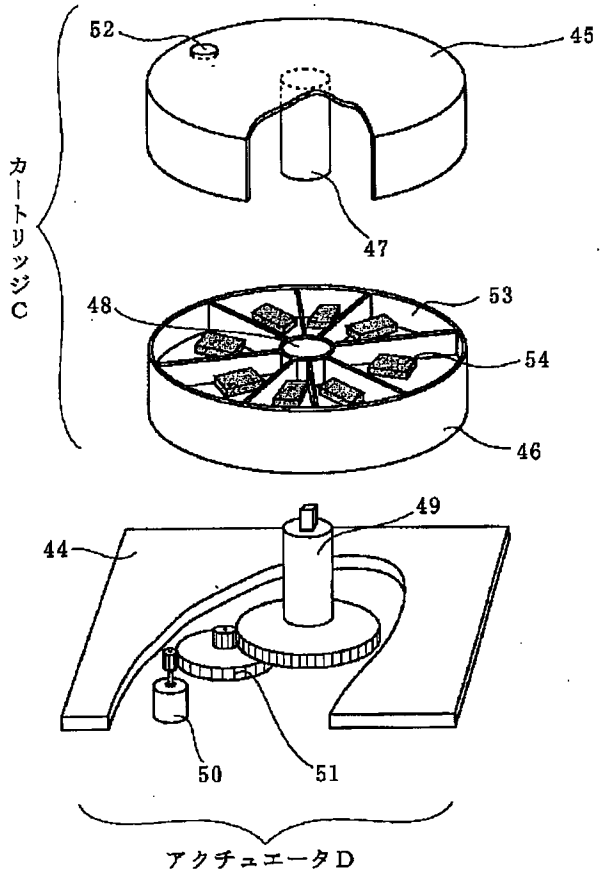
[Drawing 6]

FIG. 6



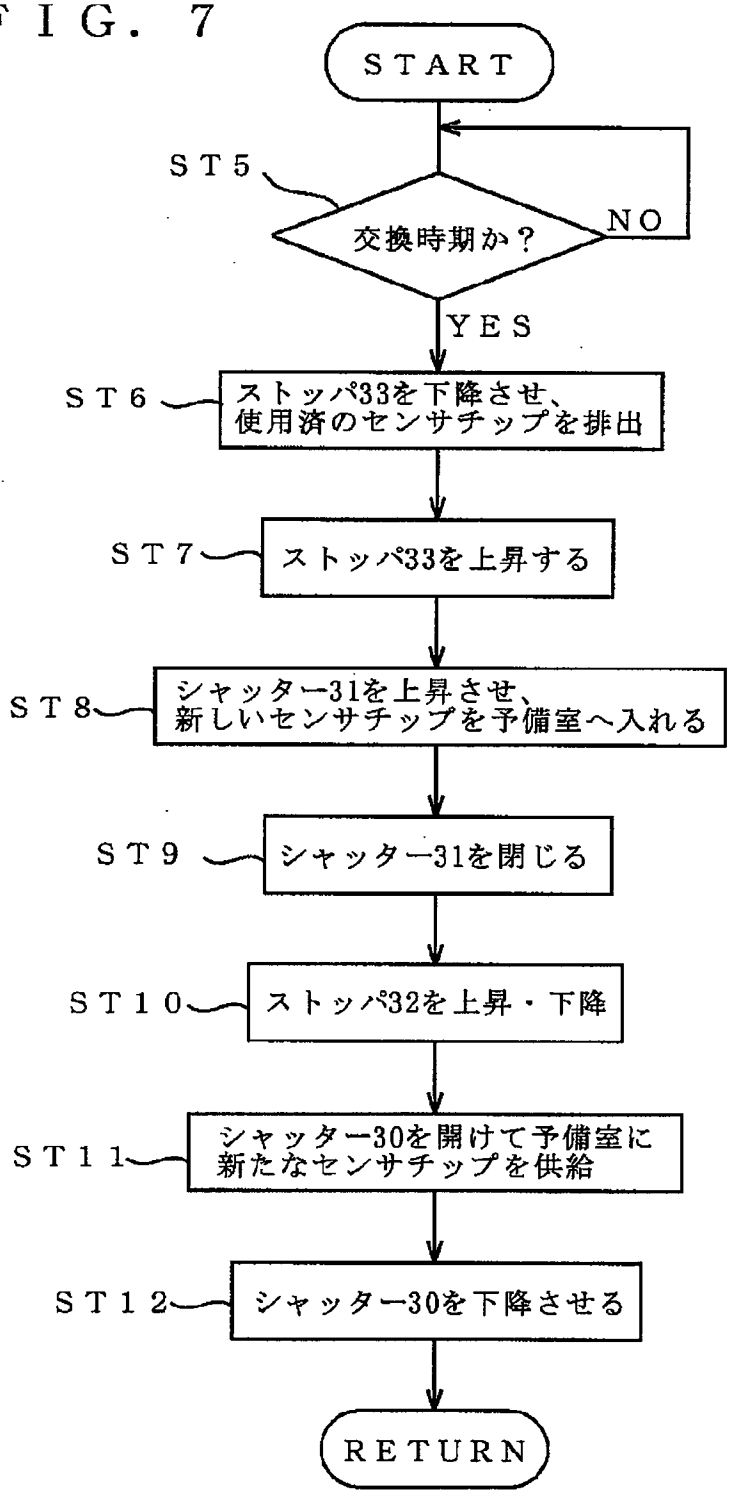
[Drawing 8]

FIG. 8



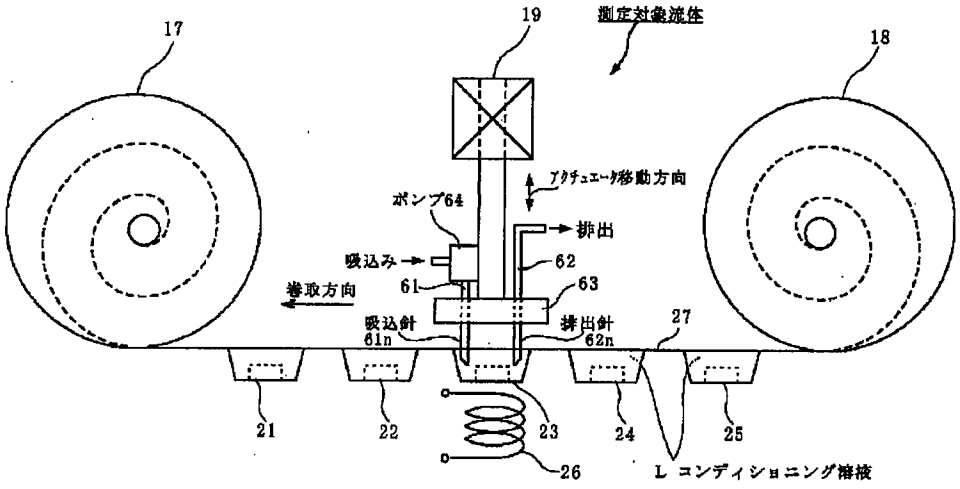
[Drawing 7]

FIG. 7



[Drawing 10]

FIG. 10



[Translation done.]